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CURRENT TRENDS IN AUGMENTED REALITY AND FORECASTS ABOUT THE FUTURE

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Abstract

Augmented Reality (AR) is the enrichment of the objects and spaces in the physical world through the use of computer generated artificial, virtual and synthetic 3D elements. Different from virtual reality, AR does not replace the actual world, but rather it enriches the actual world environment with 3D digital elements. AR can be used in many different fields, such as military research, the games industry, medicine, and engineering, and is becoming increasingly widespread as an innovative technology and an interdisciplinary field. In particular, the fact that mobile devices such as smartphones and tablet computers have more powerful processors, higher resolution screens and more highly-developed cameras, and are empowered with features such as GPS, digital compasses and accelerometers, has contributed to AR becoming ever more widespread. There are several reports (Horizon Reports, Abi Research, Juniper Research Reports) regarding the current and future status of AR that include some anticipation. The common point of all the reports is the fact that AR will become more widespread and effective in the future. Although this study contains the trends in the fields such as engineering, game sector and marketing its focal points are "educational environments" and "open and distance learning". Particular focus will be on AR usage within the context of educational technologies and making forecasts for the future. The study will be supported with infographics, tables and visuals and a detailed analysis will be made. In the relevant literature no similar comprehensive literature analysis has been encountered. This study is expected to fill this gap in the literature. In this study, an implication is aimed to be made through analyzing all trend reports about AR in the literature, articles, and other academic publications through conducting an in-depth literature review and content analysis methods. As a result, a contribution to the literature will be made through a comprehensive study that includes predictions about the current and future status of AR.

Keywords: Augmented reality, virtual reality, educational technology, open and distance learning, trends, forecasts, in-depth literature review.

1 INTRODUCTION

Augmented reality (AR) is an emerging form of experience in which the real world is augmented by computer-generated content which is tied to specific locations and/or activities [1]. Unlike with Virtual Reality (VR), AR users do not dive into artificial worlds with their entire field of vision [2].

The first ideas about AR are found in the book "The Master Key" written by L. Frank Baum and published in 1901 [3]. Although the author is known for his novel The Wizard of Oz, he has used some imaginary objects based on his imagination regarding AR in his novel The Master Key. In the novel, Rob, who is interested in and curious about electricity, finds the main key of electricity by chance and summons "The Demon of Electricity". As a result, electrical devices are given him as gifts and Rob's adventures with these devices are counted. One of these gifts is the so-called "Character Marker". If someone looks at a person through these glasses, they mark personal characteristics of the person such as bad, good, smart, and rude. In doing so, they show the initial of the characteristic on the person's forehead. These glasses in the book are regarded as one of the first ideas about the use of AR [3], [4], [5]. In the following years, many technological developments related to AR were experienced. The most important break points can be listed as follows:

Table 1. The History of AR.

Year	Product	Inventor/Company
1957	Sensorama simulator	Morton Heilig
1968	The Sword of Damocles	Ivan Sutherland
1996	First marker-based AR system	Jun Rekimoto
1997	Touring Machine (First mobile AR system)	Feiner, MacIntyre, Höllerer and Webster
1999	Eye Tap (The ancestor of smart glasses)	Steve Mann
2002	AR Quake (First mobile AR game)	Thomas, Close, Donoghue, Squires, Bondi and Piekarski
2008	First AR based bionic contact lenses	Babak Parviz
2012	Google Glass	Google
2015	Microsoft Hololens	Microsoft

AR is currently classified into many display systems and applications. When AR types are examined, it is seen that classification is as follows [6]:

- Handheld Devices
- Stationary AR Systems
- Spatial Augmented Reality (SAR) Systems
- Head-mounted Displays (HMDs)
- Smart Glasses
- Smart Lenses

Apart from this, different classifications are also made. In a classification made, it can be seen that AR is divided into various categories as "Tracking Technology", "Display Technology" and "Input and Interaction Technologies" [7].

It is important to determine the current situation of AR, used in various sectors and divided in various applications, software, hardware, and to predict the future developments that can be experienced. In this century, where information and communication technologies (ICT) affect every aspect of the lives of individuals, AR is one of the most attractive and popular one of these technologies and the way it will affect our lives and educational experiences is unclear. It can be said that the trend reports of the major technological organizations especially include the most accurate information and future predictions in the determination of the current situation about AR. Within the scope of this study, it is tried to determine the current situation and future predictions of the AR by examining the existing trend reports.

2 METHODOLOGY

In this study, "in-depth literature review" method is used. "In-depth literature review" is used to examine the literature more intense, deeper, with more sizes and more components in a wider scope, to perform a healthier analysis, to make more accurate assessments and to understand the current situation better [8], [9], [10]. In this study, current reports and trends are analyzed in depth and future predictions are included.

3 CURRENT SITUATION AND FUTURE FORESIGHTS

In recent years, AR applications have become widespread very rapidly. At the same time, market share in this area is growing and investments are increasing. This study discusses the situation and future of the AR in recent technological trend reports. Primarily, "Horizon Reports", that aims determining trends in educational technology and contains the most respected research in the field of education.

Through the analysis of 2004-2017 Horizon Reports, which determine the learning technologies trends of the future, AR has firstly been mentioned in the 2005 report along with the context-aware computing [11]. In this report it was envisaged that AR would find widespread usage in learning processes. Later, AR has been directly mentioned in 2006-2010-2011 reports. Although they did not give place to AR directly, in 2013 and 2015 reports it was envisioned that wearable technologies in regards to AR would become widespread, and in 2016 Horizon report, which is the most current one, “Augmented and Virtual Reality” were demonstrated as one of the pioneer technologies that would become widespread in 2-3 years [12]. Within this context, it can be claimed that usage of AR, which has ranked among significant developments in the higher educational technologies since 2005, will become widespread.

In the study titled “Hype Cycle for Emerging Technologies” conducted by Gartner Inc. in 2015 [13], in its fifth level theme called “Digital Business” the focus is on convergence of people, businesses and objects and connection between them. AR ranks at the fifth level and is shown among the trends that are thought will reach widespread usage in 5-10 years. In its sixth and the most advanced level the same report contains “autonomous” technologies, which are humanoid capabilities or abilities that can replace humans. Under this theme are unmanned equipment, quantum computers, bio-chips, humanoid smart robots as well as VR, virtual personal assistants and holographic viewers.

This report was also published in the 2017 version.

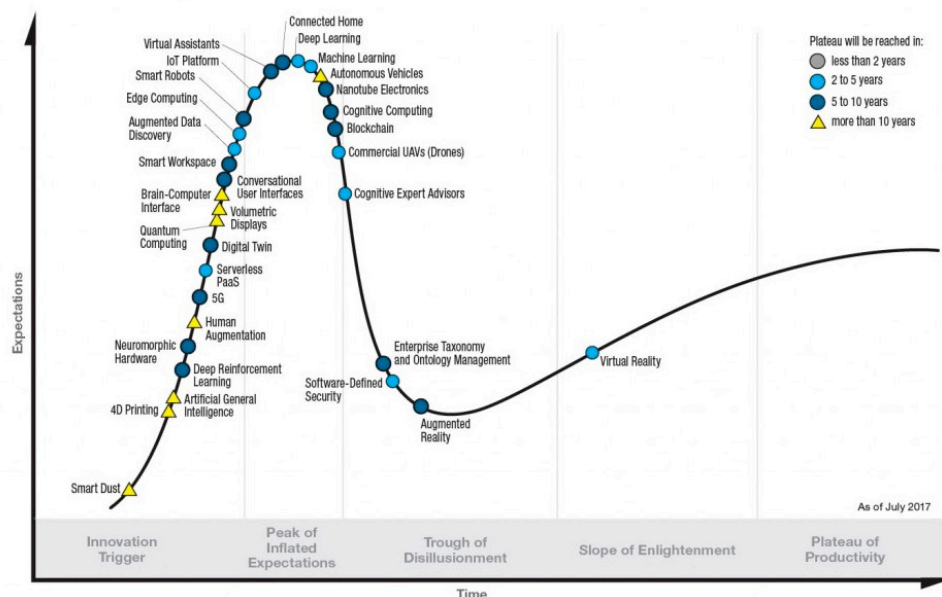


Figure 1. Gartner hype cycle for emerging technologies 2017 [14].

Gartner Inc. published a new report titled "Gartner Hype Cycle for Emerging Technologies 2017" that sets mega trends [14]. The report focuses on three emerging technology mega-trends: Artificial intelligence (AI) everywhere, transparently immersive experiences and digital platforms. Under the title "Transparently Immersive Experience" it is a remarkable trend to have both AR and VR. The trends referred to as "Transparently Immersive Experience" are as follows:

- 4D Printing
- Augmented Reality (AR)
- Brain-Computer Interface
- Connected Home
- Human Augmentation
- Nanotube Electronics
- Virtual Reality (VR)
- Volumetric Displays

In the time dimension, AR is located in the "Trough of Disillusionment" section. However, VR is in the "Slope of Enlightenment" phase [14].

According to a report by ABI Research 2013 [15], which employs world renowned analysts working on technological change and transformation, and which makes instructive quantitative forecasts and qualitative analysis for future oriented decisions of institutions in the information and communications fields, points out that the cloud computing is the most likely field that would develop along with AR. In addition, the "Internet of Things" and "Big Data Analytics" are believed to be the fields which can be integrated with AR. According to ABI Research report [16] the most prominent revenue generators in AR market are highlighted as education, games, healthcare services, industrial applications and retail. In another ABI Research report [17], it is envisioned that number of headset viewers that work with mobile devices will reach to 65 million units and revenues will be \$ 1.6 billion in 2020.

In its report titled "Mobile AR: Smartphones, Tablets and Smart Glasses 2013-2018" Juniper Research [18], one of the technology research companies, mentions that annual revenues in sectors in the AR services and applications have reached to \$1.2 billion. The number of single users of AR applications has risen to 60 million in recent years and this figure is expected to reach to 200 million by 2018. In addition, it is envisioned that users of AR applications will use the game based and location based applications the most by 2018. Likewise, it is considered that AR applications will be used in daily life / healthcare services, multimedia /entertainment sector, businesses and social networks.

The prediction of "Location Based" applications becoming widespread in Juniper Research report is supported also in XcubeLabs report. XcubeLabs estimates that revenue from "Location Based" applications will be higher in its report "Augmented Reality Apps The future is real + virtual" [19]. It is remarkable that these two reports confirm each other. At the same time, the increase in income of this area is interesting, although it is a narrow usage area in "social networking" applications. It is also anticipated that AR revenues and market share will gradually grow in games.

In a report of Goldman Sachs in 2016, about the use of AR in education, the worth of educational software produced with AR is expected to be \$300mn in 2020 and to rise to \$700mn in 2025 [20]. The same report is stated that smartphone shipments will increase more rapidly than tablets and the difference will increase even further until 2025. According to this report, VR/AR HMD market has the potential of reach over \$100bn annually by 2025.

The same report is listed in the most active areas of VR / AR in the future. These fields are as follows:

- Videogames
- Live events
- Video entertainment
- Healthcare
- Real estate
- Retail
- Education
- Engineering
- Military

Gartner's report titled "Top 10 Personal Technologies to Support Digital Business," lists the technologies that will have the most impact in the following way [21]:

- Virtual Personal Assistants (VPAs),
- Machine Learning (ML)/Artificial Intelligence (AI) and
- Immersive Technology (augmented reality [AR], virtual reality [VR] and mixed reality [MR])

"Immersive technology" enables users to mix the real and digital worlds via AR, VR and MR. It is striking that the AR, one of the immersive technologies, also takes part in the report. It is also mentioned that wearable technologies such as "wristbands, smartwatches, HMDs and smart clothing" and 3D cameras can also be used as AR applications in this report.

Although Pokémon Go received most of the attention, 2016 was a big year for AR and VR with an increase in the availability HMD devices. The current technology lacks maturity, but as its sophistication deepens, its adoption rate will accelerate at a modest pace through 2020. Gartner estimates by mid-2016, more than 7 million HMD devices were in the hands of consumers [22].

Another report on HMD devices supports this claim. According to IDC, the number of HMD devices is estimated to be 100 million units in 2021 [23]. According to forecasts, these devices will be cheaper, as well as lowering basic hardware requirements, which will accelerate the growth of the market [23], [24].

With AR, shopping habits of users are also expected to change. "Gartner Predicts 2017: Marketers, Expect the Unexpected" also estimates that 100 million consumers will shop for AR applications up to 2020 [25]. This insight demonstrates that AR will deeply affect our lives in many ways and that consumer behaviour will change over the coming years.

Fjord, one of the world's leading digital design agencies, completed one of the most recent trend reports [26], [27]. In this study, the result of 12-month research, the most important developments that are supposed to affect design and innovations for the business, the government and society in the coming years are shared. In the report, 2017 trends are collected in titles and the content includes various topics from autonomous vehicles to artificial intelligence and chat bots, from AR to the internet of things (IoT). Like in almost all of the technological trend reports, AR is also mentioned in this report as one of the important technological developments, proving that it will mark the future.

4 CONCLUSIONS

The history of AR and wearable technologies is as old as the drawings of the first people on the cave walls [28]. The first applications of AR consisted of cumbersome wearable computers and hardware. The smart glasses were designed to be integrated with the eye and to be inserted and removed with the operation. In the process between L. Frank Baum's prophecy of "Character Marker" glasses in 1901 to teleportation with holograms (holoportation), the whole development graphic of AR is affected by developments in ICT. In the future it is foreseen that wearable technologies, smart goggles, holograms, mobile applications and contact lenses will become more widespread [5].

In particular, there is a need for more academic research to explore the potential of the AR in education and in open and distance learning. AR can revolutionize education. But without content, AR is not estimated to be effective enough just as a product of educational technology. Also, integration with other areas should not be forgotten. It should be taken into consideration that an AR application developed in the military or medical field can be used to be extremely useful in education.

With the recent advancement of ICT, it has become easier for the learners to interact with each other [29]. With AR, interaction can be achieved not only between learners but also with other objects. For example, static (non-interactive) objects such as printed books, can become interactive with "marker". Educational AR applications can now be used with devices such as smartphones and tablets that are in the hands of many learners.

In addition to the fact that AR could find area of usage in various disciplines, it has also common research fields with some science fields that were newly emerged in recent years. Although as a multidiscipline field AR is intertwined with 3D Computer Graphics, Computer Imaging Systems and Human-Computer Interaction fields [30], there are many AR studies particularly integrated with Robotics field [31], [32], [33]. In the future, other than robotics, AR is expected to provide more original applications through creation of common research fields with such science fields as nanotechnology and biomimicry [34]. On the other hand Bower et al. expect that in the coming years in regards to AR, experiences involving more senses will become more widespread, smarter input recognition devices will be used and AR will become more interrelated to such concepts as "Internet of Things" [35]. It is also estimated that AR applications integrated with artificial intelligence gain more advanced features. In the near future, social networking applications such as Facebook and Twitter are planned to be fully presented with AR. It is known that Facebook is already beginning to invest in this subject.

AR has the potential to be more powerful and more effective by being integrated with other technologies. For example, the impact of Pokémon Go, which has been causing great repercussions in a short time, is still being discussed. This AR game has been downloaded more than 100 million times in the first month and earned \$ 10m per day [36]. At this point, the greatest danger relates to how users perceive this technology. In 2017, Mindshare Trends conducted a survey about the views of the individuals in the community on AR and 32% of participants stated AR as only a fad, and 43% believes that this technology is a bit of gimmick [37]. At this point, again, the example of Pokémon Go can be given. In the first 3 months, this game, which has caused great effects on the world and has taken people to the streets, showed a rapid decline in the following period. The interest of the users has begun to disappear and the download count of the application has decreased. The drop in

popularity is an issue that needs to be questioned. Time will tell whether AR is a technology that will influence all aspects of our daily lives or just a fad that will become boring for people.

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